[Portland Cement Concrete] [Granular Base] [Embankment or Fill]

RECLAIMED CONCRETE MATERIAL Material Description

ORIGIN

Reclaimed concrete material (RCM) is sometimes referred to as recycled concrete pavement (RCP), or crushed concrete It consists of high-quality, well-graded aggregates (usually mineral aggregates), bonded by a hardened cementitious paste The aggregates comprise approximately 60 to 75 percent of the total volume of concrete

RCM is generated through the demolition of Portland cement concrete elements of roads, runways, and structures during road reconstruction, utility excavations, or demolition operations

In many metropolitan areas, the RCM source is from existing Portland cement concrete curb, sidewalk and driveway sections that may or may not be lightly reinforced The RCM is usually removed with a backhoe or payloader and is loaded into dump trucks for removal from the site The RCM excavation may include 10 to 30 percent subbase soil material and asphalt pavement Therefore, the RCM is not pure Portland cement concrete, but a mixture of concrete, soil, and small quantities of bituminous concrete

The excavated concrete that will be recycled is typically hauled to a central facility for stockpiling and processing or, in some cases (such as large reconstruction projects), processed on site using a mobile plant At the central processing facility, crushing, screening, and ferrous metal recovery operations occur Present crushing systems, with magnetic separators, are capable of removing reinforcing steel without much difficulty Welded wire mesh reinforcement, however, may be difficult or impossible to remove effectively

CURRENT MANAGEMENT OPTIONS

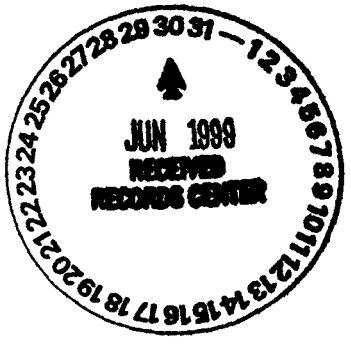
Recycling

Reclaimed concrete material can be used as an aggregate for cement-treated or lean concrete bases, a concrete aggregate, an aggregate for flowable fill, or an asphalt concrete aggregate It can also be used as a bulk fill material on land or water, as a shore line protection material (rip rap), a gabion basket fill, or a granular aggregate for base and trench backfill

Disposal

Disposal in landfills, near the right-of-way, and in borrow pits or depleted quarries has historically been the most common method of managing RCM However, recycling has become a more attractive option, particularly in aggregate-scarce areas and in large urban areas where gathering and distribution networks for RCM have been developed

MARKET SOURCES



ADMIN RECCRD
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Recycled concrete material can usually be obtained from central processing plants where the processed material is stockpiled and sold Well-processed RCM will normally yield consistent physical properties , but RCM properties can sometimes vary depending on the properties of the quality of the recovered concrete

Variations between concrete types result from differences in aggregate quality, aggregate size, concrete compressive strength, and uniformity [1] For instance, aggregates in concrete not exposed to severe weathering (such as footings and covered structural members) can contain a higher proportion of deleterious substances than those in pavement concrete Precast concrete generally has smaller aggregate size, higher compressive strength, and less variation in strength and other properties than cast-in-place concrete Some recycled pavements may show evidence of distress from alkali-silica reaction due to the presence of a siliceous aggregate with reactive constituents In areas where deicing salts are extensively used, recycled concrete may contain relatively high levels of chlorides

HIGHWAY USES AND PROCESSING REQUIREMENTS

Aggregate Substitute

The use of RCM as an aggregate substitute in pavement construction is well established, and includes its use in granular and stabilized base, engineered fill, and Portland cement concrete pavement applications Other potential applications include its use as an aggregate in flowable fill, hot mix asphalt concrete, and surface treatments

To be used as an aggregate, RCM must be processed to remove as much foreign debris and reinforcing steel as possible Reinforcing steel is sometimes removed before loading and hauling to a central processing plant Most processing plants have a primary and secondary crusher The primary crusher (e g , jaw crusher) breaks the reinforcing steel from the concrete and reduces the concrete rubble to a maximum size of 75 mm (3 in) to 100 mm (4 in) As the material is conveyed to the secondary crusher, steel is typically removed by an electromagnetic separator Secondary crushing further breaks down the RCM, which is then screened to the desired gradation To avoid inadvertent segregation of particle sizes, coarse and fine RCM aggregates are typically stockpiled separately

MATERIAL PROPERTIES

Physical Properties

Processed RCM, which is 100 percent crushed material, is highly angular in shape Due to the adhesion of mortar to the aggregates incorporated in the concrete, processed RCM has rougher surface texture, lower specific gravity, and higher water absorption than comparatively sized virgin aggregates As processed RCM particle size decreases, there is a corresponding decrease in specific gravity and increase in absorption, due to the higher mortar proportion adhering to finer aggregates High absorption is particularly noticeable in crushed fine material, which is less than 4 75 mm in size (minus No 4 sieve size), and particularly in material from air-entrained concrete (since there is substantially more air-entrained mortar in the fine than the coarse RCM aggregates) The minus 0 075 mm (No 200 sieve) fraction is usually minimal in the RCM product Some typical physical properties of processed RCM are listed in Table 14-1

Processed RCM is generally more permeable than natural sand, gravel, and crushed limestone products [2]

Table 14-1 Typical physical properties of processed reclaimed concrete material [3]

Property	Value
Specific Gravity - Coarse particles - Fine particles	 2 2 to 2 5 2 0 to 2 3
Absorption, % - Coarse particles - Fine particles	 2 to 6 4 to 8[a]
a Absorption values as high as 11 8 percent have been reported [1]	

Chemical Properties

The cement paste component of RCM has a substantial influence on RCM alkalinity Cement paste consists of a series of calcium-aluminum-silicate compounds, including calcium hydroxide, which is highly alkaline The pH of RCM-water mixtures often exceeds 11

RCM may be contaminated with chloride ions from the application of deicing salts to roadway surfaces or with sulfates from contact with sulfate-rich soils Chloride ions are associated with corrosion of steel, while sulfate reactions lead to expansive disintegration of cement paste RCM may also contain aggregate susceptible to alkali-silica reactions (ASR) When incorporated in concrete, ASR-susceptible aggregates may cause expansion and cracking

The high alkalinity of RCM (pH greater than 11) can result in corrosion of aluminum or galvanized steel pipes in direct contact with RCM and in the presence of moisture Similarly, RCM that is highly contaminated with chloride ions can lead to corrosion of steel

Mechanical Properties

Processed coarse RCM, which is greater than 4 75 mm in size (No 4 sieve size), has favorable mechanical properties for aggregate use, including good abrasion resistance, good soundness characteristics, and bearing strength Typical mechanical properties are given in Table 14-2 Los Angeles Abrasion loss values are somewhat higher than those of high-quality conventional aggregates Magnesium sulfate soundness and California Bearing Ratio (CBR) values are comparable to conventional aggregates

Table 14-2 Typical mechanical properties of reclaimed concrete material

Property	Value
Los Angeles Abrasion Loss (ASTM C131), (%) - Coarse particles	 20-45[2,3]
Magnesium Sulfate Soundness Loss ASTM C88), (%) - Coarse particles - Fine particles	 4 or less[2,3,4] less than 9[1]
California Bearing Ratio (CBR),(%)*	94 to 148[3 4]
* Typical CBR value for crushed limestone is 100 percent	

The results of a 6-year Long Island, New York, study of materials processed from uncontrolled stockpiles for use as a granular subbase or base, presented in Table 14-3, reveal that physical properties such as magnesium sulfate soundness, Los Angeles Abrasion, density, and CBR of processed RCM are very consistent and can be expected to fall within a predictable range of values [5]

Table 14-3 6-year study of RCM from uncontrolled stockpiles on Long Island, NY[5]

Physical Property	Test Results		
	Mean	Std Dev	Tests Performed
Magnesium Sulfate Soundness (%)	3 8	1 3	107
Los Angeles Abrasion (%)	36 5	3 6	112
Dry Density (lb/ft^2)	129 0	2 6	143
CBR (%)	148 0	28 7	157

REFERENCES

1 Yrjanson, William A *Recycling of Portland Cement Concrete Pavements*, National Cooperative Highway Research Program Synthesis of Highway Practice No 154, National Research Council, Washington, D C , December, 1989

2 Hanks, A J and E R Magni *The Use of Recovered Bituminous and Concrete Materials in Granular Base and Earth,* Report MI-137, Ontario Ministry of Transportation, Downsview, Ontario 1989

3 ACPA *Concrete Paving Technology* Recycling Concrete Pavement, American Concrete Pavement Association, Skokie, Illinois, 1993

4 Petrarca, R W and V A Galdiero "Summary of Testing of Recycled Crushed Concrete," *Transportation Research Record No 989*, pp 19-26, Washington, DC, 1984

5 Personal Correspondence, Richard Petrarca, Twin County Recycling, Hicksville, New York, 1995

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